PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference mj92-PCT	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International Application No. PCT/AU2002/001163	International Filing Date *(day/month/year)* 29 August 2002	Priority Date *(day/month/year)* 28 June 2002

International Patent Classification (IPC) or national classification and IPC

Int. Cl. [7] B41J 2/05, 2/045, B81B 7/02, 7/04

Applicant

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1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

   [X] This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 3 sheet(s).

3. This report contains indications relating to the following items:

   - I [X] Basis of the report
   - II [ ] Priority
   - III [ ] Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV [ ] Lack of unity of invention
   - V [X] Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI [ ] Certain documents cited
   - VII [ ] Certain defects in the international application
   - VIII [ ] Certain observations on the international application

Date of submission of the demand	Date of completion of the report
14 October 2003	3 March 2004
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer **STEPHEN CLARK** Telephone No. (02) 6283 2781

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/AU2002/001163

I. Basis of the report

1. With regard to the **elements** of the international application:*

☐ the international application as originally filed.

☒ the description, pages **1-24**, as originally filed,
pages , filed with the demand,
pages , received on with the letter of

☒ the claims, pages , as originally filed,
pages , as amended (together with any statement) under Article 19,
pages , filed with the demand,
pages **25-27**, received on **26 February 2004** with the letter of **26 February 2004**

☒ the drawings, pages **1-42**, as originally filed,
pages , filed with the demand,
pages , received on with the letter of

☐ the sequence listing part of the description:
pages , as originally filed
pages , filed with the demand
pages , received on with the letter of

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages

☐ the claims, Nos.

☐ the drawings, sheets/fig.

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report*

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-10	YES
	Claims		NO
Inventive step (IS)	Claims	1-10	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-10	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

1. EP 1057637
2. EP 1057639

Novelty (N), Inventive Step (IS) Claims 1-10

None of the citations alone, or in combination, disclose all of the features of any of the claims.

In particular, the above two citations are the closest art found, but they do not include the feature of a thermal bend actuator that acts on the ink when a signal from the drive circuitry is received. Each of these citations includes CMOS drive circuitry, a micro-electromechanical actuators and a distance between the circuitry layer and the movable member within the range of 2-15 microns, however the movable member is not a thermal bend actuator but just a movable member, acted upon by a heated ink bubble.

We claim:

1. An ink jet printhead chip that comprises

a wafer substrate,

a CMOS drive circuitry layer positioned on the wafer substrate, and

a plurality of nozzle arrangements positioned on the wafer substrate and the CMOS drive circuitry layer, each nozzle arrangement comprising

nozzle chamber walls and a roof wall that define a nozzle chamber and an ink ejection port defined in the roof wall, and

a micro-electromechanical actuator connected to the CMOS drive circuitry layer and that has at least one thermal bend actuator that is positioned to act on ink in the nozzle chamber to eject the ink from the ink ejection port on receipt of a signal from the drive circuitry layer, the signal directly causing thermal bending of the actuator, the, or each, thermal bend actuator being spaced between 2 microns and 15 microns from the CMOS drive circuitry layer.

2. An ink jet printhead chip as claimed in claim 1, in which the at least one movable member of each nozzle arrangement is spaced between 5 microns and 12 microns from the CMOS drive circuitry layer.

3. An ink jet printhead chip as claimed in claim 2, in which the at least one movable member of each nozzle arrangement is spaced between 6 microns and 10 microns from the CMOS drive circuitry layer.

4. An ink jet printhead chip as claimed in claim 1, in which the nozzle chamber walls and roof walls of each nozzle arrangement are configured so that the nozzle chambers are generally rectangular in plan and transverse cross section, each movable member being planar and rectangular to extend across a length of its respective nozzle chamber, with a free end of the movable member positioned between the CMOS drive circuitry layer and the ink ejection port and an opposed end of the movable member being anchored to the CMOS drive circuitry layer, the movable member incorporating heating circuitry that is electrically connected to the CMOS

drive circuitry layer, the movable member being configured so that, when the heating circuitry receives a signal from the CMOS drive circuitry layer, the movable member is displaced towards the ink ejection port as a result of differential expansion and, when the signal is terminated, the movable member is displaced away from the ink ejection port as a result of differential contraction.

5. An ink jet printhead chip as claimed in claim 1, in which the movable member comprises an actuator arm of a conductive material that is configured to define a heating circuit that is connected to the CMOS drive circuitry layer and is configured to deflect towards the wafer substrate as a result of differential expansion when an electrical signal is received from the CMOS drive circuitry layer, and the roof wall of the nozzle chamber and at least part of the nozzle chamber walls connected to the actuator arm, so that, when the actuator arm is deflected towards the wafer substrate, ink is ejected from the ink ejection port defined in the roof wall.

6. An ink jet printhead that includes a plurality of printhead chips as claimed in claim 1.

7. A method of fabricating an ink jet printhead chip having a wafer substrate, a CMOS drive circuitry layer positioned on the wafer substrate and a plurality of nozzle arrangements positioned on the wafer substrate and the CMOS drive circuitry layer, each nozzle arrangement having nozzle chamber walls and a roof wall that define a nozzle chamber and an ink ejection port in the roof wall and a micro-electromechanical actuator connected to the CMOS drive circuitry layer the actuator having at least one thermal bend actuator that is positioned to act on ink in the nozzle chamber to eject the ink from the ink ejection port on receipt of a signal from the drive circuitry layer, the signal directly causing thermal bending of the actuator, the method comprising the steps of:

depositing between 2 microns and 15 microns of a first sacrificial material on the CMOS drive circuitry layer to define a deposition area for a layer of actuator material,

depositing said layer of actuator material on said deposition area,

etching the layer of actuator material to form at least part of each micro-electromechanical actuator, and

forming the nozzle chamber walls and roof wall by at least one of a deposition and an etching process.

8. A method as claimed in claim 7, which includes the step of depositing between 5 microns and 12 microns of the first sacrificial material on the CMOS drive circuitry layer.

9. A method as claimed in claim 8, which includes the step of depositing between 6 and 10 microns of the first sacrificial material on the CMOS drive circuitry layer.

10. A method as claimed in claim 7, in which the step of forming the nozzle chamber walls and roof wall of each nozzle arrangement includes the steps of

depositing a second sacrificial material on the layer of actuator material to define a deposit area for at least part of the nozzle chamber walls and the roof wall,

depositing a structural material on the deposit area, and

etching the structural material to form the at least part of the nozzle chamber walls and the roof wall.